DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

PROBLEMS OF PROGRESS IN INDUSTRY—I

MEN STEEL AND TECHNICAL CHANGE

by the
Industrial Research Section
Department of Social Science
University of Liverpool

LONDON: HER MAJESTY'S STATIONERY OFFICE
1957

Preface

THE OBJECT of this new series is to present briefly and simply the results of new research into the social, economic and technical problems of industrial progress—problems arising from automation and other advances in technique, and problems of management and human relations. The booklets are either 'industrial versions' of academic reports that have been, or soon will be, published elsewhere; or short reviews of research done independently by several teams. The series is planned in the belief that responsible officials on both sides of industry feel the need to digest and use new research material but have not the time to browse through full-length volumes.

The series is commissioned and edited by the Department of Scientific and Industrial Research, which seeks only to provide a forum for responsible new thinking and to stimulate independent discussion and action, including further research. The conclusions and speculations are those of the investigators, mostly from the universities and other well-known research bodies, and they are not necessarily those of the Department.

This issue, prepared by Olive Banks and W. H. Scott, is based on an intensive study of technical change in a large British steelworks. The study was made by the Industrial Research Section of the Department of Social Science at the University of Liverpool. It was supported by the Department of Scientific and Industrial Research with counterpart funds derived from U.S. economic aid.

A full report of the study has been recently published (W. H. Scott, J. A. Banks, A. H. Halsey and T. Lupton: *Technical Change and Industrial Relations*, Liverpool University Press, 1956, 17s. 6d.). This short and selective summary is not a substitute for the report but an outline of the important findings. Many conclusions are omitted, also many of the facts on which they are based and many detailed reservations that limit their applicability to other situations.

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*London, S.W.*1 *September*, 1957

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All charts except that on pages 18 and 19 are by the Isotype Institute

Introduction

HOW DOES TECHNICAL change, notably that which leads to automation, affect employees and their relations with employers? What makes them view it with favour—or disfavour? In what conditions do they accept it, rather than resist it?

There have been several recent studies of these questions, usually confined to particular aspects like changes in skills and status. This booklet, by contrast, springs from an intensive survey of the problems in one company making steel. It traces the relationship between technical and social changes, especially during the last 20 years. First the technical changes are summarized, also the trends in the size and composition of the labour force. Then the problems of management are reviewed, above all those arising from increased specialization. Next, relations between trade unions and management during each period of change are examined and their part in securing a smooth acceptance of change is assessed. Finally, the attitudes of employees to change are studied, with special emphasis on furnace crews in the new melting shop.

I. The Technical Changes

THE CHOSEN COMPANY, which desires to remain anonymous, has successfully completed two great technical changes in the last 20 years. Founded in 1851 as a small family business making nails, it is now a large integrated steelworks employing more than 9000 workers. Its technical history can be divided into four distinct phases:

(1) 1860–1928. In 1860 the company began to make steel sheet from puddled iron by 'hand rolling'. On moving to the present site in 1896, it had developed this side of the business so far that it decided to concentrate on making sheet. In the following decades it continued to expand the hand mills and built two melting shops; but it made no technical innovation.

(2) 1928–1937. This was a transitional period during which the technique of hand rolling was modified in a department making high-grade sheet, so as to meet the quality requirements of the growing motor industry.

(3) 1937–1946. In this decade the company built a continuous strip mill and a cold mill with ancillary equipment; these gradually replaced the hand mills.

(4) 1946 – A new open-hearth melting shop has been built and other plant, including coke ovens, a blast furnace and equipment for processing by-products, has been introduced for the first time.

This booklet deals with the technical changes of the third and fourth phases, since they are more relevant to current problems than the others and, being of more recent origin, yield fuller information. What kinds of change were they and how did they affect the work done by employees of the company?

The continuous strip mill

In the hand mill a team of ten men undertook all the operations. Some supervised the heating of steel bars in a small furnace; others, using tongs, passed the hot bars from the furnace into a pair of small, powered, horizontal rolls; and a third group handled the sheet when it emerged from the rolls. The work was fast, hot and physically exacting, and the senior operatives needed considerable dexterity and skill, which they acquired through experience.

By contrast, as figure 4 (pages 18–19) show, there is no handling of the sheet in the strip mill. Steel slabs, on leaving the furnace, pass unaided along a delivery table to a series of heavy rolls and the operatives have only to control the machinery by operating levers and buttons according to either a written production schedule or dial readings or both. Most, though not all, of them still work in small teams, as shown in figure 4, but each team is based on one operation, or one section of the process, and not on the whole process as in the old hand mills.

Less skill of the conventional type is required in the strip mill than in the hand mill because successful rolling depends less on the judgment and dexterity of the operatives. But more responsibility is placed on them, because an error may be very costly and may bring the continuous process to a stop. Working conditions are much better than in the hand mills; the tasks are not physically arduous and the atmosphere is less oppressive.

The new melting shop

This shop, in which steel is produced from a mixture of molten iron from the blast furnace and scrap iron, replaced two old shops, the first of which dated from 1902 and the second from the first world war. During the 1940s, some measuring instruments were introduced to the second, but not to the first.

The new shop is much larger and roomier than the old ones, its furnaces are much bigger and it has modern equipment giving semi-automatic control of the process. The main tasks of the melters are to prepare and clean the furnaces and to control the process. The furnaces are still manned by teams of four men apiece, but each is composed of men from both the old shops. The plant operates continuously, which means for melters what is known as a continuous working week. Each man works on different days from one week to the next, and he does not often get a completely free week-end.

Both the strip mill and the melting shop imply a large degree of automation. The strip is rolled continuously by machinery and instruments measure critical variations in, for instance, the thickness of the sheet and the temperature of the furnace; but operatives have to control the machinery. Instruments also record the performance of open-hearth furnaces in the melting shop, and much of the control there is automatic. Yet in neither the strip mill nor the melting shop is control so highly automatic as in an oil refinery, where the main task of the operatives is to check the efficiency of control mechanisms.

II. Effects on the Labour Force

During the four phases of technical advance, there have been far-reaching changes in the size and composition of the company's labour force.

Size

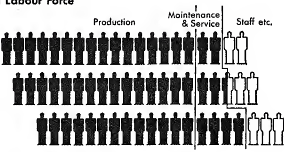
The company employed only a few hundred workers when it moved to the present site in 1896, but by 1928 it had 6000 on its books. Numbers did not grow much during the transitional phase, which was one of re-organization rather than expansion, nor during the establishment of the strip-mill nor even during the last war. But growth was resumed during the final phase of development and it is still going on.

Composition

Technical change tends to alter the balance of the labour force; it increases the numerical importance of salaried staff, including managers and specialists, and of skilled men engaged on service and maintenance, and it lowers that of direct labour. The experience of this steel company illustrates the trend. Figure 1 shows that the proportion of staff and craftsmen doubled between 1925 and 1953 while that of the production workers fell. It actually understates the trend, because in those years many maintenance workers were grouped with production workers in the company records and their numbers cannot be stated separately.

There have also been important changes within the three main groups of employees. The staff group has become more mixed and technicians like laboratory assistants and instrument mechanics have increased in number—from 15 per cent of the

Changes in Labour Force



Each symbol represents 5 p.c. of adult labour force

Figure 1

total staff in 1924 to 25 per cent in 1955. In the works the leading hands have declined in number but the craftsmen have increased from 7 to 11 per cent of the company's labour force between 1925 and 1953. In the same period craftsmen attached to the sheet-making process have increased from 4 to 10 per cent.

These changes have had two important effects. First, they have created new problems of recruitment and selection, especially in the cases of apprentices and technical staff. More emphasis has had to be laid on formal qualifications and less on family ties, although these are still much in evidence. Secondly, they have affected industrial relations; the craft unions have recently been seeking to raise the status of their members in relation to production workers and, in a recent dispute, have revealed their discontent with the present position. This problem is discussed on pages 16, 17 and 20.

III. Problems of Management

History

For almost fifty years the company was owned and managed by members of one family, whose subordinates were not foremen in the modern sense but contractors who supplied and paid the workmen. Only gradually, towards the turn of the century, did management emerge—at both the plant and departmental levels—as a separate function between the members of the owning family on the one hand and foremen-contractors on the other. This trend was quickened by the growth of activities at the present site, and by the early years of this century there existed a distinct management group. Further progress followed the introduction of the continuous strip-mill in the late 1930s.

This innovation stemmed from changes in the kind of steel sheet required, and especially from the decline in demand for the traditional galvanized sheet that set in during the 1920s. To meet this decline the company at first experimented with a black sheet of higher quality to meet the new requirements, and eventually became the biggest producer of it in Britain except for one company in South Wales. But the firm ran into practical difficulties and had to place part of the rolling mills under American management, because only in this way could it get people with the necessary experience. It put an American superintendent in charge and a small team of American managers in some junior positions. New items of equipment were also introduced, especially in the finishing of the sheet. These moves brought some success, but before long it became abundantly clear that if the company was to meet the demands of the new market, it had to do more than modify the old hand-rolling process; it therefore decided to install fully mechanized hot and cold strip mills.

It had been realized as early as 1928 that this step might have to be taken, but for many reasons it took ten years to reach a final decision. One was the sheer magnitude of the change: 'The group of machinery representing a continuous rolling plant is the most costly in the world', said the managing director in 1928. Secondly, it was by no means certain that the market, at least in Britain, could absorb the increased production of high-quality sheet—especially after the depression of the 1930s, which both slackened the demand for sheet and created temporary unemployment in the company.

A third reason was that the new mill required what was in those days an enormous amount of capital, and this may have been very difficult to secure at a time when funds were being sought for another strip mill in South Wales, which was interested in tinplate and not black sheet. Fourthly, the management naturally wanted to avoid redundancy, which, it feared, would follow the change. Finally, there were differences within the ranks of management. The new men brought in to manage the high-grade sheet mill did not always see eye to eye with the 'old guard', who still regarded hand rolling as their 'bread and butter'. The company eventually overcame these problems, but only decided finally to go ahead after it had fully considered all the changes and prospects.

The post-war innovations followed logically from the strip mill because, once sheet of high quality was being produced in large quantities, more high-grade steel was needed. The company installed a blast furnace, along with coke ovens and ancillary plant, so that it could supply hot metal to a new open-hearth melting shop.

Specialization

Continuous rolling has led to a further expansion of management, and to the creation and elaboration of specialized and 'service' functions in management. For example, the production units have become closely interdependent; there must be a steady flow of material from one to another if each is to work continuously and economically. Yet the company has a variety of orders on its books and so must be flexible in operation while maintaining a uniformly high quality of output. These apparently conflicting needs are reconciled by a *scheduling and production* department.

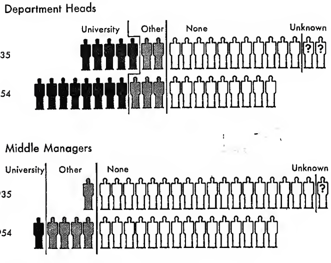
Again, the demand for sheet of high quality, and consequently for special steels, has made *steel research* a separate function and the laboratory has more plentiful and varied work to do than before. The *progress and statistics* department has a similar background, while a special *raw materials* department has arisen from the need for materials in greater amounts and varieties. In addition, a *development and constructional engineering* department was created to examine new engineering problems in the construction of plant. Other new functions, such as *statistics and negotiation* and *work relations*, are linked with changes in the structure of occupations that have come with the new mills.

There have been two important effects on the organization of management. First, the company needs more managers with technical qualifications and has had to recruit more of them from outside its ranks. Secondly, it has found increasing difficulty in co-ordinating the structure of management. The first effect is particularly interesting. In the early years of the company, sons of the founder-family were the managers; then, as management became a separate function, men were recruited from the ranks, and they derived their authority from their deep, first-hand knowledge of the process. But the technical changes of later years, beginning in the transitional period and gathering momentum in the integrated plant, emphasized the need for managers with more specialized knowledge and training, which few of the existing staff either had or could obtain. Employees in offices, laboratories and engineering departments still have reasonable prospects of becoming managers, but elsewhere opportunities are shrinking and the balance of managers has to be found outside the company. Figure 2 shows that over half the departmental heads now have degrees, compared with a third in 1935; and that the proportion of professionally qualified managers has doubled among departmental heads and trebled among middle managers.

Administrative problems have also been complicated by the advent of new production departments and the development of specialized and service functions. In the days of the small family business members of the family could communicate with the operating managers on friendly and even intimate terms, and had no need of formal organization. The foremen-contractors were jealous of their independence and inclined to resist both formal authority and central controls. It is not surprising, therefore, that even today the company should stress informality in personal relations and that senior managers should have considerable discretionary power.

Yet, since the management has grown in size and become varied in function, it has proved difficult to keep relations informal and exclude all systematic co-ordination of the work of senior managers. Some problems arise from the sheer numbers of men exercising managerial control and from the wide 'span of control' by the general manager. There are also problems of co-operation between specialists, especially between production and service managers, who may not always see their powers and responsibilities in the same light—either because they perform different functions or because they have had different education, training and experience.

To sum up, the function of management grows in importance with technical change and more recruits are needed with formal and specialized qualifications. It becomes more difficult than before to rise from the ranks and there is a possibility, at least in the transitional phase, of rivalry among groups who differ in function or personal background. The growing size and complexity of management may increase problems of co-ordina-



Qualification of Managers

Each symbol represents 5 p.c. of the group

Figure 2

tion and control, and the trend towards specialization may in time lead to the creation of a management group composed entirely of professional men, who are formally recruited and trained and who possess definite qualifications. This trend may foster a more unified outlook among managers.

IV. Relations between Trade Unions and Management

In contrast with some other industries, industrial relations in steel have always been good; both sides have wanted to settle differences by peaceful means, and systems of consultation have been developed by which grievances and differences may be quickly resolved. What has been the impact of technical change on the traditional pattern of relations within the company?

In spite of a temporary setback during the General Strike, relations were fairly stable and mutually satisfactory by 1928. The two unions of production workers (The Iron and Steel Trades Confederation (I.S.T.C.)* for the main processes like steel-making and rolling, and the Transport and General Workers Union for finishing, transport, etc.) had exclusive negotiating rights, which gave each of them a virtual monopoly in organizing the workers for whom it catered. The company would not concede an official union shop but it gave preference to union members in promotion from one grade to another. This concession was bound to encourage membership of unions in an industry where high wages are gained as a result of advancement within a given section of the process.

The company's attempt in the early 1950s to produce a sheet of higher quality did not cause any radical or abrupt departure from existing techniques. It did, however, make work variable, slower and to some extent intermittent, and so it threatened a fall in output bonuses and intensified union activity.

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* To avoid confusion only the negotiating body, the ISTC, is mentioned here. The actual trade union is the British Iron, Steel and Kindred Trades Association (BISAKTA), which provides the usual welfare benefits to its members. This dual arrangement is derived from the history of trade-union amalgamation in the steel industry, which is too complicated to be summarized here.

But these were the years of depression, and external conditions weakened both the power of the unions to press their claims and that of the company to concede them. Consequently operatives in the experimental mill did suffer some temporary loss of pay.

The unions were then concerned solely with problems like wage-rates, manning-scales and promotion; at no time did they take part in the initial staffing of a process. Established custom had given employers in this industry an absolute right to recruit labour from any source when manning a new process, and the unions did not challenge this right.

The strip mill

In 1937 the decision to install a continuous mill revived, and even intensified, the passing anxiety over unemployment, short-time working and experimentation that was felt among employees in the two sheet-producing departments. Redundancy appeared certain; only 200 of the 1700 production workers in the hand mills were required on the new hot mill, although many more might be absorbed in due course on the cold mills and in the finishing departments. There was, moreover, a fear, especially among the older employees, that seniority might be discounted because the work required was very different from that on the old mills. Other questions loomed up. How arduous would the work be? Could existing employees adapt themselves to their new jobs?

The management decided that the unions should be asked to help man the new process from the start. This was a new departure from the tradition that a steel company has the right to man a plant, but the unions willingly co-operated and discussions continued throughout 1938. It was finally agreed that men from the old mills should have the chance to volunteer for the new jobs and that selection should be by seniority except for men in their late fifties or sixties, who would be passed over to secure a more balanced distribution of age in the new mill. The unions, for their part, would submit four names for every job in the new mill and from such a list the management would choose one man.

The transfers were made over a long period and no department was entirely closed during the early years. The second world war eased the problem, since many men were taken into the armed forces and some of the old hand mills stayed in production throughout hostilities owing to the increased demand for steel. All this meant much less redundancy than had been feared in 1937, when the unions agreed to co-operate. The only serious problem concerned workers aged over fifty-five, many of whom had reached senior positions in the old mills. These who applied for transfer were all found jobs in other departments of the company, but they often suffered a big fall in wages.

The melting shop

Developments since the war have been less radical than this. The new melting shop is modern and incorporates some changes in melting practice, but the basic nature of the work has not altered. The change did involve redundancy, however, as furnaces were fewer and bigger (see page 6). The coke ovens and blast furnace were also new departures for the company and redundant melters transferred to them found the work very different.

The first and foremost problem was to select labour for the new melting shop, since most of the men would clearly prefer to remain on their usual jobs in a more modern shop. Other problems were: how to fix rates of pay, hours of work and a new set of arrangements for seniority and promotion.

Once more the company was prepared to co-operate with the union—only one union, the I.S.T.C., was concerned—but this time it got a flat refusal from the lay representatives. Later, at a meeting between the union's district officer, lay representatives and senior managers, the union nominees re-emphasized the right of the company to man a new plant and asked it to do so in view of the problems and personalities concerned in this change. The task was certainly a difficult one, but the union had already shared responsibility for manning the strip mill—with apparent success—and its reasons for refusing on this occasion are not altogether clear. It may have been affected by differences between two local branches, each representing one of the old melting shops. Their disagreement dates from the first world war, when the second melting shop was erected, and in a dispute of 1934 the I.S.T.C. had to appoint a sub-committee to bring together the conflicting views. Some traces of this rivalry remained after the last war, and in refusing to help man the new shop the union may well have been anxious to avoid a repetition of the 1934 dispute.

In the event the senior plant manager worked out the new scheme. Labour was selected from the old shops (half from each) according to seniority; but the older operatives were passed over, as with the strip mill, and some men lost seniority within their grades. The older men were found jobs as amenities attendants, cleaners and labourers, while younger men not transferred to the new shop were usually recruited to the blast furnace or the coke ovens.

The negotiation of pay and conditions in the new melting shop presented some problems. The company had long wanted to replace local agreements, under which men were paid in proportion to the tonnage they produced, by a sliding scale so arranged that the rate per ton decreased as the tonnage increased, after passing a certain figure. It had also wanted to introduce a continuous working week and so operate the plant more efficiently, but had been reluctant to press its wish—against strong opposition from the union branches—because of the tradition in the steel industry that there can be no change in working conditions without a change in the process, except by agreement. The new shop brought a change in process and gave the company the chance it had been waiting for. So it was that, when the transferred melters began to work the new furnaces, they were paid on a revised basis (that of the North-East Coast Agreement) and they worked between them a continuous week.

When it came to negotiating pay and working conditions for the blast furnace and coke ovens, the unions found the company in a generous mood and they secured good results. That is not to say that all the men benefited from the change; some were demoted, even in the new departments, and a few older men fell the whole length of the job hierarchy. But in general the new rates and conditions were favourable and the younger men secured good opportunities for promotion—at least initially. The company was anxious to gain co-operation and was willing and able to pay the price the unions were asking.

The impact on craftsmen

The impact of technical change on craftsmen has been less immediate and less severe than on production workers, because their work consists of maintaining and repairing and they do not operate the productive processes. Yet there have been long-term effects on industrial relations. First, the craft working force has grown and so has the ratio of craftsmen to production workers. Secondly, mechanization has increased the importance of craftsmen, but they find themselves in a dilemma; they want to share more fully the material advantages of the production workers (although this might involve a fuller acceptance of shift work, closer identification with the company and other big changes in outlook), but they also want to preserve their traditional advantages and their allegiance to their crafts.

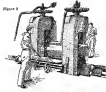
This difficulty is of recent origin. Before the last war the craftsmen's wages were negotiated by a District Engineering Committee, which covered craftsmen in all local industries. Not, apparently, until 1945 did the craftsmen in steel become aware of their special problems. They then asked to be included in agreements applying to craftsmen on the north-east coast and in other steel centres. Four years later, a national body—the National Joint Trade Union Craftsmen's Iron and Steel Committee—was set up to ascertain and express the common problems of the craftsmen in the industry. Within the plant individual craft unions still continued to meet independently until 1951, when a joint committee of shop stewards was formed and, at the same time, a joint district committee was set up to serve the area as a whole.

The craft shop stewards seem to agree on their main grievances. They feel that the growing importance of their crafts is being recognized slowly and grudgingly by the company and the production unions, and they consider that they are still looked on as a necessary evil. They have already expressed their sense of grievance on three occasions—in a dispute between the shop stewards' committee and the district committee, in an overtime ban during 1955 and, more recently, on the question of week-end overtime.

There have also been problems for the unions themselves, notably how to draw lines of demarcation between one union and another. For instance, the introduction of the continuous strip mill has altered the numerical balance between those workers who roll and those who finish the sheet. As a result the lines of jurisdiction between the I.S.T.C. and the T. & G.W.U.

LAYOUT OF THE CONTINUOUS STRIP-MILL

Figure 5



An early type of sheet rolling mill. The metal was handled with tongs into and out of the rolls. Now rolling is continuous, as shown below, and the hot and exacting physical work has been mechanized.

1 *Operator* (another name for roller) is in charge of the whole process from furnace-reheating to coiling. Does nothing but supervision if all is going well. Decides when rolls shall be changed and supervises the change. Rolls may be changed during lulls in order to save time, but otherwise when (15) notifies him of flaws in the sheet.

2 *Operator's helper* (i.e. assistant roller) keeps an eye on temperatures, pressures, speeds, etc. shown on the instrument panel. Assists in changes of roll and in any emergency; otherwise helps the roller with supervisory duties. Changes the gauge on the five finishing mills with (14).

3 *Furnace-recorder* works the tables, bringing the slab up to No. 1 mill. Keeps in touch with the crew of the reheating furnace to ensure that the slab is of the correct grade of steel. Decides from which furnace each slab will come. Works from his schedule.

4 *Rougher* adjusts the gauge and width of the three roughing mills.

5 *Rougher's helper.*

6 *Rougher's operator* operates the rolls and the approach tables for the roughing mills.

7 *Helper to rougher's operator* assists the rougher's operator and operates the water-squirts on the roughing mills.

8 *Delay-table operator* switches on the water-jet to cool each slab as it approaches the finishing mills. Notes the temperature of the slab on the delay table and delays it if it is too hot to go through the finishing mill.

9 *Guide-setters* adjust the width of the guides on the finishing mills in roll changes.

10 *Speed-operator* controls the speed of the strip from the delay-table through to the coiler. In practice he operates the last three finishing mills.

11 *Speed-operator's helper* operates the first two finishing mills.

12 *Looper-operator* operates the lifting tables between the finishing mills to break up the scale.

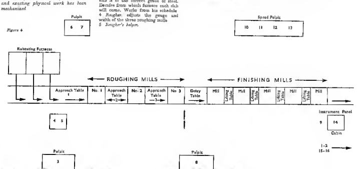
13 *Shear operator* works the flying shears. Sets them, when rolling plate, and is notified by (15) if they are incorrectly set. When rolling strip for coil, he judges when to operate shears so as to chop off the last few feet of strip.

14 *Finisher* watches the strip coming out of the finishing mills and ensures that it is running straight by pressing buttons, when necessary, to tilt the rollers carrying the strip. Changes the gauge on the finishing mill with (2).

15 *Gauger* works down by the coiler. Checks the strip or plate for correctness of gauge and width and (if plate) length. Signals (13) and/or (2) if anything goes wrong.

16 *Gauger's helper.*

Figure 4



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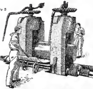

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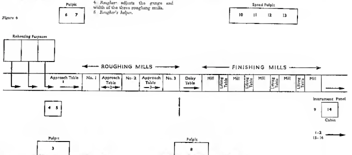
16 *Gauger's helper*

Figure 4



have had to be redrawn. Again, the opening of the blast furnace and the coke ovens raised the question as to who should organize the coke-oven operatives. This issue was finally brought to arbitration and settled in favour of the I.S.T.C. Disputes of this kind, though important to the union as a unit of power, are probably not taken seriously by the workers themselves. A production operative who becomes redundant on one process is given a job on another and there can be no question of denying him the job because he has not served an apprenticeship for it. There has, therefore, been none of the bitterness so frequent in demarcation disputes between craftsmen's trades when the worker's right to the job is directly involved.

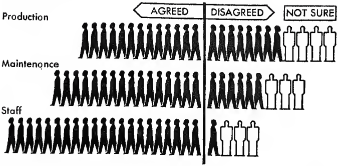
So far, neither the introduction nor the absorption of technical change has been seriously opposed by the trade unions in spite of a possible loss of status and wages and, in the case of the strip mill, of the possibility of serious redundancy. The grievances of craftsmen are a possible exception, but even these exist, not because craftsmen oppose technical innovation as such, but because they believe that their position has worsened in relation to that of the production workers. Why has adaptation been so successful? One factor—the company's readiness to work with the trade unions—has already been noted; but to find the other causes it is necessary to look at the employees' attitudes in detail.

V. Attitudes to Technical Change

Possible changes

A sample survey has been made in order to find out, among other things, the general attitudes of the company's employees to the wider implications of technical change. Respondents were told of an imaginary change involving redundancy and were asked to comment on a number of statements and opinions about it, indicating whether they agreed, disagreed, or were uncertain. The situation was put in this way:

> I want to read to you some statements and opinions from a discussion which took place recently among a group of men employed



I think the firm should put in new machinery

Each symbol represents 4 p.c. of those questioned *Figure 5*

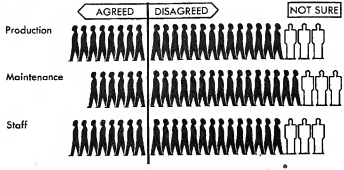
at a large manufacturing plant. The facts which they were discussing were as follows. The directors were considering whether or not to put in some new machinery. If they put in the new machinery it would mean that 500 workers would have to be laid off and it was absolutely impossible for the firm to find them new jobs in the plant.

The replies to each statement are analysed at length in the full study. Here the most important of them are briefly discussed and the conclusions summarized.

The first statement, 'I think the firm should put in the new machinery', was agreed with by 51 per cent of the production workers, 64 per cent of the maintenance men and 86 per cent of the staff (including all except senior managers). Within these groups there was a close correlation between attitude and status. The leading hands favoured the new installation more often than their crews but less often than their foremen, while the craftsmen were more inclined to accept it than their mates but less than their chargehands.

Another statement ran: 'Yes, it is the directors' job to make as much profit as possible. If this means redundancy for some of the workers, that is just too bad.' When the issue was put in this way, more than half of those previously in favour of change withdrew their support. As many as 56 per cent of the production men, 65 per cent of the maintenance men, 54 per cent of the staff as a whole and even 32 per cent of the managers

Yes, it is the director's job to make as much profit as possible, even if it means some redundancy



Each symbol represents 4 p.c. of those questioned

Figure 6

disagreed with the statement. Again there was a correlation between attitude and status; the lower the status, the more likely was the respondent to disagree with the statement.

The next three statements referred to the rights of management and unions. Three-quarters of the staff, including managers, thought that the company had the right to install new machines, with or without the agreement of unions. A similar percentage thought that the union would be wrong to oppose the new machinery and that men should not go on strike against the new machines even when their own jobs were affected. The production men were generally more ready to oppose the rights of management than the maintenance men; 38 per cent of them, for example, thought the unions would be right to oppose the new machinery compared with only 30 per cent of the maintenance men. This disparity is even clearer in reactions to a statement on strike action; two-fifths of the production men were ready to go on strike in the circumstances described, but less than three-tenths of the maintenance men. The unskilled production labourers were the most ready to support union rights and to strike.

Another statement, made topical by recent events in the motor-car industry, suggested that the company should put all workers on short time as a temporary expedient to avoid redundancy. Three-fifths of the managers, two-thirds of the staff and four-fifths of the wage earners agreed with this. An alternative suggestion, taken from the actual experience of a U.S. steel plant, was that the company should compensate workers with three months' wages. Respondents as a whole backed it less than short-time working; only a third of the staff and just over half of the production workers agreed with it and nearly three-fifths of the staff and more than a third of the men from the works disagreed with it. But some of the production men were expressing not opposition to the principle of compensation but merely inability to believe that any company could be so magnaminous as to pay it. All told, five in six of the production workers thought that somebody—the company or the Government—should be responsible for paying it.

To sum up: the higher the occupational status, the greater is the support for technical change in the face of unpleasant social consequences, the greater is the support for the rights of management, and the less is the approval of union claims. At each occupational level the maintenance men favour technical change more than the production men but are less willing to approve the claims of both management and unions. Possibly they tend this way because their skill makes them largely independent of the fortunes of individual companies and they know it. By contrast, the reactions of the supervisory staff reflect to a large extent their identification with the company. These findings seem to bear out the results of other research, which reveal different attitudes among the occupational groups.

Actual changes

The next step was to explore the attitudes of employees to changes they had actually experienced while employed by the company. All these changes occurred some years ago, so the first reactions to them have been overlaid by later events and the attitudes expressed have sprung from recollection of the changes rather than the changes themselves. Also, those interviewed were 'survivors', men who have stayed with the company since the changes, so the evidence is probably biased towards the favourable aspects of change. These limitations of the inquiry must be borne in mind.

The company's labour force has been so stable that well over a third of its present number witnessed the establishment of the high-grade sheet department in 1928; they are now mostly managers, supervisors and senior members of the production teams. As many as 12 per cent of those interviewed said they had been personally affected by changes that took place during the transitional period (1928–37). Three-fifths of the present labour force were with the company when it installed the new strip mill in the late 1930s, and a third of those interviewed said they were affected by it. The corresponding figures for the 'melting shop' change after the war were 89 per cent and 36 per cent.

Those who had been personally affected by each change were asked to assess its impact on such matters as wages, hours, conditions of work and social life outside the works. Table I. summarizes their answers. The three changes are seen nowadays to have had rather different consequences. For example, more men said they lost wages and chances of promotion through the installation of the strip mill than through the other two changes. Yet the strip-mill change was seen as the most favourable to improvements in working conditions. Analysis of this kind is inadequate because not many respondents were affected by the two earlier changes and because little is known about the actual

TABLE I. OPINIONS OF EMPLOYEES CONCERNING THEIR EXPERIENCE OF TECHNICAL CHANGE

	1925–37 HIGH-GRADE SHEET-MILL CHANGE			1938–46 STRIP-MILL CHANGE			1952–54 MELTING-SHOP CHANGE		
	Better (B), Worse (W), Indifferent (I)								
	B %	*W* %	*I* %	*B* %	*W* %	*I* %	*B* %	*W* %	*I* %
Wages (amount)	47	18	35	37	29	33	41	22	37
Wages (type)	12	13	75	15	18	67	10	9	81
Security	54	15	32	59	9	32	43	4	53
Promotion	27	7	66	10	24	66	5	8	87
Promotion chances	34	7	59	21	27	53	18	7	75
Hours	11	13	76	17	28	55	25	19	57
Conditions	34	17	49	43	16	41	31	16	54
Social Life	7	8	85	5	17	79	11	16	72

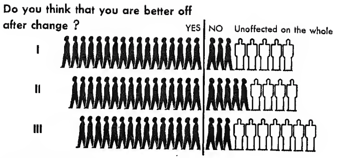
TABLE II. OPINIONS, CLASSIFIED BY OCCUPATIONAL CATEGORIES, OF THE EFFECTS OF THE MELTING-SHOP CHANGE

	STAFF			PRODUCTION			MAINTENANCE		
	Better (B), Worse (W), Indifferent (I)								
	B %	*W* %	*I* %	*B* %	*W* %	*I* %	*B* %	*W* %	*I* %
Wages (amount)	25	9	66	49	23	28	34	25	41
Wages (type)	–	2	98	12	11	77	10	8	82
Security	54	–	46	45	4	51	38	4	58
Promotion	21	5	74	2	8	90	4	9	86
Promotion chances	39	2	59	16	8	76	16	7	77
Hours	13	24	63	23	27	50	30	6	64
Conditions	25	21	54	19	18	63	48	12	40
Social Life	7	18	75	19	24	65	14	6	80

consequences of these changes. But the latest change (the new melting shop) can be analysed further. Table II. compares the reactions of staff, production and maintenance men to it.

Certain broad differences emerge from this table. First, more manual workers than staff complained of a loss in wages; yet more of them reported a gain too, because two-thirds of the staff were indifferent. This is because the wages of manual workers are affected by a re-organization of work during technical change, especially when it is tied to a production bonus; but staff salaries are less likely to be affected, except when there is promotion or demotion. Secondly, the staff found the change more favourable to promotion, or chances of promotion, than did the men in the works. Thirdly, there was a good deal of dissatisfaction with the effect of the change on hours of work and social life. This was partly due to the introduction of continuous working. The average working week was not lengthened—indeed for some it was shortened—but, for those who changed over to continuous working, week-ends were no longer as free as they had been. The shift foremen who went over with their men were also dissatisfied; but not the maintenance workers, most of whom had previously worked long hours of overtime at the week-ends and now worked fewer.

Few workers reported a change for the worse under any head.

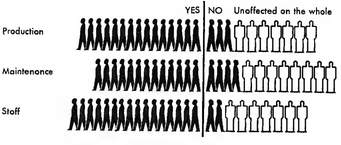


Each symbol represents 4 p.c. of those affected

Figure 7

The highest figure in the 'worse' columns of Table I. is 29 per cent, representing those who spoke of a fall in wages as a result of the strip-mill change. This generally favourable view was confirmed when respondents were asked whether they thought themselves on balance to be better off, worse off, or unaffected by each change. Figure 7 shows that only a small minority found any of the changes unfavourable on the whole, though more of them reacted favourably to the strip mill change than to the other two. (It is important to remember here the possible bias mentioned on page 23.)

Figure 8 shows in detail the reactions to the more recent melting-shop change. The staff employees seem to be the most



Each symbol represents 4 p.c. of those affected

Figure 8

satisfied and the maintenance workers (i.e. the craftsmen) the least satisfied. This confirms earlier findings on the grievances of craftsmen since the last war.

It is not easy to assess what criteria workers used when estimating the impact of technical change. Nor is it possible, with existing material, to decide exactly how opinions about technical changes compare with actual experience of change. To take one example, craftsmen, in contrast with other workers, complained that they lost wages after the strip mill was installed, but there is not enough information on which to test the truth of the complaint. What facts there are suggest that workers in all the occupational groups earned more but that craftsmen gained less than the others. They felt deprived, but only by comparison with fellow workers. As might be expected, workers' reactions seem to be closely related to gains or losses in wages, status and other respects—either absolutely, or, as with the craftsmen, by comparison with other groups.

It is difficult to relate these attitudes to particular changes with the general attitudes to technical change that were expressed in replies to hypothetical questions. But some links can be suggested. The staff employees show a fairly strong enthusiasm for technical change because they are identified with the management and may share the company's belief in efficiency. Craftsmen, on the other hand, seem to value technical achievement for its own sake, possibly because they have craft skill, because they depend less than production workers on one industry or process, and because their numbers and importance have increased as a result of technical change.

VI. The Melting Shop: A Case Study

In order to interpret attitudes more precisely, a more intensive survey has been made of the furnace crews in the new melting shop. These men, a fairly small and homogeneous group, had all been employed in the open-hearth shops before the change, and their new tasks were very similar to the old. Few of them suffered changes in job rank and most received an increase in real wages. How did the change actually affect them and how did the actual effect compare with their view of it?

Wages

An analysis of melters' earnings in 1949–50, two years before the new shop was opened, and in 1955, two and a half years afterwards, shows how the actual wages of individual melters changed. But the facts do not correspond in a fifth of the cases with the melters' opinions of them. Thus three melters from No. 1 Shop said they were no better off financially as a result of the change, although their money wages had risen by three-quarters and their real wages (allowing for the rise in the cost of living) by a third. Similarly, a melter from No. 2 Shop, whose money wages had gone up by a half and real wages by a sixth, claimed to be worse off.

Fortunately it is possible to guess from an analysis of the men's comments what criteria of comparison they were using. For example, three said they were down-graded in 1952 and fell behind men of the same grade from the same shop; although their wages later rose, they tended to think of what they might be earning if they had not been down-graded. Others complained of the new method of calculating tonnage bonuses; they tended to compare their earnings after the change with an enhanced figure representing in their minds what they might have been taking home if the new method had not been introduced.

Clearly both groups of melters compared, not wages before and after the opening of the new shop, but earnings as they were and as they would have been, in the men's view, had the change not occurred. Thus men from No. 1 Shop took into account not only their total pay, but the hours they worked, their tonnage bonus and their position relative to other workers transferred from No. 1. As a rule, they did not compare their wages with those of men from No. 2.

Promotion and demotion

There is a similar confusion among melters on this subject. As many as 22 of those interviewed claimed that they had been demoted as a result of the melting-shop change; yet, according to the company records, not one of them lost rank in this way. The reason for this discrepancy is clear. The men think of promotion prospects in terms not only of movement from grade to grade (there are four grades of melters called 'hands') but up the ladder of seniority within each grade, which carries them step by step through one grade to the next. For example, a second hand who goes back six or seven positions within his grade is that much farther from promotion to first hand, so he considers himself to be demoted.

Continuous working

There is no doubt that continuous working is regarded by many of the men as a cause of serious deprivation. When asked 'In what way were you affected by the change?' 51 mentioned the loss of the week-end and its effect on social and family life. The remaining 45 were not indifferent on this issue; though they put other matters first, nearly half of them complained of it when asked specific questions about their social life.

In particular, Saturday shifts must prevent regular attendance at sporting events, and this is more significant for those who play than for those who watch, although important to both. A few melters say they have had to curtail or abandon other interests. A Sunday School teacher of long standing has felt obliged to hand over the work to someone else; another man has been forced to take less part in local politics; while a third can no longer be a judge at local flower shows. These cases are exceptions, but 48 men in all and in addition, 17 wives* reported that they had been prevented from keeping up their regular association with a sports or social club, or with a religious or political body.

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* In a separate study of melters' wives, 75 out of 105 were interviewed. The results have been published; see Olive Banks 'Continuous Shift Work: the Attitudes of Wives', *Occupational Psychology*, April 1956, p. 69, and for a short summary, W. H. Scott 'The Housewife looks at Shift Work', *The Manager*, July 1956, p. 544.

The effect of the continuous working week on family life is also important. As many as twenty-seven of the men (over a third of those with children) complained that they spend less time now with their children, it being schooltime when they are off work during the week. A dozen melters, mainly fathers whose children are too young for school, said they are better off because they see more of their children than before, but some pointed out that once the children go to school this advantage will be lost.

Yet all these men have been accustomed to a three-shift system and have done week-end overtime for most of their working lives. No melter in the old shops rose to the rank of first hand without doing the 'watching shifts' that were obligatory on fourth and second hands. The present grievance arises from the fact that Sunday work has become frequent and concerns all grades and that, for the first time, shifts are worked on Saturday afternoons and nights. A melter now has only seven free week-ends (2 p.m. Saturday to 10 p.m. Sunday) in a cycle of 42 weeks and the rota has to be arranged so that his days off fall differently each week. The rotas are published well in advance so that the men can plan their lives ahead, but even so they regarded week-end working as a serious inconvenience at the time they were interviewed. This happened soon after the change, of course, and it is not yet known how far they and their wives will eventually become used to the new system.

As many as thirty-six of the men complained that they have less time with their wives than before. This may seem surprising, because the working week has been shortened, but the men had in mind the difficulty of adjusting household routines to the continuous working week. Husbands used to a week-end of leisure and social life with their wives find themselves at home in mid-week, when the wives are quite unable or unwilling to vary their routine, and they have, as one disgruntled melter put it, to amuse themselves or 'help with the washing'. Melters' wives were also aggrieved by the loss of week-ends with their husbands; nearly two in five of those interviewed found it the worst aspect of continuous shift work.

Human relations

How did change affect human relations in the new melting-shop? One managerial problem was how to bring together men from two rival shops, only one of which (No. 2) had experience of modern instruments and methods and so had partly equipped its workers for the change. The two managers of the new shop, who had to give close supervision in the early days, were recruited from No. 2 shop, so understandably most of the men who criticized their new relations with the shop management came from No. 1 shop. Apart from this, there appears to have been some friction at first among the men themselves. Some men from No. 1 had to seek advice from No. 2 men, who considered that the former had been promoted above them though knowing less about how to run the new furnaces. This put the No. 1 men at a disadvantage and on the defensive. The problem was aggravated by the fact that earnings had been higher in No. 2 shop than in No. 1, so that men from No. 1 gained more financially from the change.

It has already been noted (on page 15) that on this occasion the unions refused to help the management to handle the transfer; they merely provided lists of seniority for the two shops and reserved the right to protest in individual cases. This too may have caused problems during the settling-in period because, for one thing, it made it harder to unite the two trade union branches happily, so that they could serve all members in the new shop.

Yet few men, other than active trade unionists, appeared to be very clear as to how the change was handled. Eight of them, for example, seemed convinced that the management and the unions handled it together. They were not at all sure of the criteria used in selection. Three thought that efficiency was the key factor; 'the management picked the best man for the job'. Another believed that good time-keepers had been chosen, yet another that selection was on some kind of age basis. A sixth mentioned seniority, a seventh thought that both seniority and ability had been taken into account, and the eighth was convinced that neither had any weight. Some melters thought, moreover, that the union had let them down, and should have taken part in the selection as it had done with the strip mill.

Others were inclined to excuse the union. As one put it, 'I don't blame them. They would have been blamed for favouritism.'

General reactions

Finally, what was the general reaction of the melters to the change? Were they better or worse off, on balance, as a result of it? Two-thirds of the men interviewed said that they were better off, although they had previously held that in some respects, like wages or week-end leave, they were worse off or unaffected.

This general reaction is a balance between several items, tipped on the side of general satisfaction by one item—wages. Even where there was dissatisfaction with one or more aspects of the change, the rise in wages seemed to offset it. Yet, strangely enough, a number of melters who commented favourably on wages said that they were worse off on the whole. Many of them were dissatisfied with the effect of continuous working on social life, and the increase in wages was not enough to appease them.

It is clear that the melters' attitude to their wages is not simple. When they tried to assess how changes affected their pay, they considered not merely their own earnings before and after the change, but their position in the hierarchy of seniority running upwards from fourth to first hand. Promotion by strict seniority sets out in unambiguous terms the possibilities of advancement in a process worker's career; at the same time it effectively limits his mobility between companies, between departments, and even between operations within one plant. It is understandable that melters thought promotion more important than earnings when they were asked to consider the effect of the melting-shop change on their pay.

VII. Conclusions

Why adaptation was successful

Beyond doubt this company has introduced technical changes in the last thirty years without causing any of the big conflicts that sometimes arise. The trade unions have accepted each innovation and expansion, and the men have acquiesced in and adapted themselves to the change, even if they have not always approved of it. The unions have never refused to help the company adjust a partly redundant labour force, though they did refuse to help select men for transfer to the new melting-shop.

This does not mean that the men, or their representatives, liked all the results of change. Several cases of dissatisfaction have been noted in earlier pages; yet, except for the case of the post-war craftsmen, they did not lead to open conflict, either when technical change was first proposed or during the long period of adaptation. And the general attitude, seen in retrospect, was one of widespread approval. A majority of 'survivors' of each change claimed that it had made them better off on the whole, and a fair number even of the lowest occupational groups were prepared to approve a hypothetical case of innovation, although it caused redundancy. Of course, no one should rely too much on the predictive value of these statements.

Adaptation has been fairly easy in this company because the social consequences of technical change were not so radical as to affect adversely any big group of production workers. Although minorities have suffered, especially among older employees, there have been no sweeping changes for the majority. In general, earnings have remained high, the seniority principle has been retained, and there has been little change in the relative distribution of rewards between grades. Similarly, teamwork, and a big output bonus based on it, remain principles of work organization.

The harmony of management-union relations has also helped to reduce possible conflict. Each side recognizes certain functions as legitimate and appropriate to it. Thus the unions have conceded the right of management to make technical changes and, if it so wishes, to select labour for a new process. Likewise the company has recognized the unions' claim to determine seniority and to help in arrangements for promotion.

A number of problems arising from technical change have been handled within the unions and so have not occasioned conflict between them and the management. It is probable that the machinery for handling grievances has helped to ease the process of change, since it has developed over many years and now works smoothly. Within a broad system of national agreements the union officials on the shop floor have wide powers and can deal very quickly with disagreements or grievances.

Economic factors have also helped. The steel industry has a very high ratio of capital costs to labour costs, and a modern steel plant must be kept running continuously both for this reason and because coke ovens, blast furnaces and open-hearth furnaces can suffer big losses and considerable damage if they are allowed to cool before adequate precautions have been taken. These two factors—relatively low labour costs and the need for continuous running—have helped to keep wages high; and high wages, along with the seniority principle, give employees a big stake in the company and strongly disincline them to hinder its operations. Yet high earnings and seniority systems are related: if a man's service is broken or if he is moved from one section of the process to another, his earnings will fall and he will lose his seniority and his prospects of promotion.

Craftsmen are in a different position. Increased in numbers and importance, they tend to believe that their rewards are no longer adequate. In the past they have given allegiance to their crafts rather than to the industry or the company, and only in recent years have they begun to appreciate, in their relations with management, the special position and problems of craftsmen in steel. What is more, they depend less on the company than production workers, because seniority matters less to them and because they are more mobile both inside and outside the company. Their mobility makes them more militant than production workers and helps to determine their whole attitude to technical change.

Smooth adaptation to change has depended on the company's policies as well as on high earnings, the seniority system and other characteristic features of the industry. For example, although the company could have manned the new processes from any source, it gave preference to existing employees and so caused little or no redundancy. It paid attention to the existing pattern of seniority when determining the rank of each man transferred to a new job. The management was always ready to discuss problems with representatives of employees, and these discussions continually helped it to decide on both the principles and the details of action. To employees who could not be re-absorbed in the new melting-shop it offered jobs in the coke ovens and the blast furnace on conditions that were generous compared with those of similar units elsewhere. Finally, it planned the technical changes well in advance and introduced them in phases. This greatly simplified the handling of transitional problems.

Implications for industry in general

Besides showing why adaptation to change was successful in this company, the evidence also suggests what kinds of problem are presented by technical change in general and by partial automation in particular, because the two main changes studied—the strip mill and the melting-shop—are important steps towards 'full' automation, even if they still fall short of it. Although there is little precise knowledge about the social effects of automation, there is no reason to suppose that they differ in kind (though they may in degree) from the effects of other great technical changes. The conclusions of this study may, therefore, be relevant to future problems of change.

Relations between management and unions are especially apt to influence and be influenced by technical change. Unions, and their members, will accept change and help to implement it provided managements recognize fully the part they have to play, accept agreed principles for re-allocating workers and for re-absorbing those who become redundant, and maintain or improve the rewards of those who are transferred. These conditions are unlikely to be realized, however, without effective procedures for handling problems as they arise. In particular, there is an important role for lay representatives, men who actually experience the problems and are in close touch with the affected employees.

Given prior and effective consultation between management and unions, the social problems of technical change can be overcome. Experience at this steelworks suggests (see page 25) that some sort of compensation, over and above the benefits of normal unemployment insurance, will be thought necessary by those who are declared redundant through no fault of their own.

Apart from any provision made by the State, industry may have to make provisions of its own, such as severance pay or the guaranteed annual wage; and the Ministry of Labour and National Service may have to extend its role in industrial re-deployment. More attention will have to be given to effective ways of using older employees.

The rise in the number and proportion of craftsmen, technical staff and managers will also bring up questions of education, recruitment and training, as the steel company under study realized after the last war. In particular, the need for more and better trained craftsmen must be met; this is mainly a responsibility for industry, if only because of the kind of training that must be given.

Finally, foresight and long-term planning can ease the task of re-allocating and re-training employees, especially since technical change may eventually create more jobs than it destroys. But whenever men are transferred or re-trained they are likely to attach as much importance to their social and traditional values—as revealed in the seniority system, in team work and in leisure activities and ties—as to their material rewards or to the purely technical aspects of change. Plans must take account of considerations like these.

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